

Surge Arrestors for Lightning and EMP Protection

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The numerous *Home Power* articles on system grounding point out the importance of lightning protection. Certain environmental and climatic conditions seem to indicate that lightning activity is on the increase.

Home power systems are particularly vulnerable to lightning surges. Racks, trackers, and wind towers sometimes think they are lightning rods. Solar arrays with numerous interconnections provide a large capture area for surge energy. The result can be dangerously high voltages and static charges in the system.

You may have seen the “spice bottle” sized surge protectors at the local electronics store. These consumer-grade units are low priced, but there is a whole world of industrial-grade protectors that you’ll never find in a blister pack. Power companies, the military, and TV and radio stations demand high performing spike arrestors and grounding systems. Industry has responded, and with a little ingenuity, home power systems can achieve similar levels of protection.

Shunt Protection

There are two basic kinds of surge arrestors. Shunting type protectors don’t do anything until a surge occurs. When they sense excessive voltage they momentarily switch the spiked line(s) to a direct or indirect earth ground. The turn-on voltage for a particular suppressor must be specified when you order it.

Shunting protectors tend to share part of the surge with the equipment you’re trying to protect. This is acceptable for most non-electronic equipment but may not adequately protect sensitive electronics.

The shunting protectors tend to be lower cost. For example, the LA110V lightning arrestor from Ananda Power Technologies retails for \$49. The LA100V is a Silicon Oxide Varistor (SOV) especially manufactured for use in low voltage DC systems. The LA100V protects the system by clamping the voltage at 100 VDC and is rated to dissipate 50,000 Amps and 750 Joules of energy. This arrestor responds to surges very quickly and can clamp 10,000 Amps within 10 nanoseconds. The LA100V provides both differential protection (when there is 100 V between system positive and system negative) and common mode protection (when both system positive and system negative are 100 Volts above ground). This SOV type protector contains a harmless white powder, silicon oxide, which gradually melts as it absorbs surges. If the surge is above the rating of the LA100V, the case of the unit will rupture indicating the need for replacement.

In-Line Protection

The other basic protector design is called in-line (or series). These units actually process the power that travels through them under ordinary circumstances. You must respect their current limitations and you must specify ac or DC in addition to the turn-on voltage. In-line protectors impose a slight reduction in output voltage. These protectors do not tend to share the surge with your equipment, and may be indicated where electronics are involved.

PolyPhaser Corporation makes an in-line protector for solar module (or other DC) installations which drops 0.3 Volts at its 30 Amp maximum. 0.3 Volts represents

Below: The LA100V shunting type surge arrestor.
Photo courtesy of Ananda Power Technologies, Inc.





Above: Series-type surge protector for direct current; NEMP rated. Photo courtesy of PolyPhaser Corp.

about 2% power loss on a 12 V system, or 1% on a 24 V system. This unit retails for \$89.95 in negative or positive ground, or \$104.95 in a floating ground model. A 50 Amp model is also available.

In some cases the floating ground model is most appropriate, even on negative ground systems. This is due to the National Electric Code (NEC) requirement that the connection between the negative and the earth must occur at one and only one point.

Incidentally, if the floating ground protector is installed on the array side of the PV disconnect switch, it solves the problem of ungrounded array cables when a double-poled disconnect switch is opened. If an

overvoltage appears on these lines, it will be momentarily switched to earth by the protector. (Note: depending on your electrical inspector's interpretation of the NEC, the array disconnect switch may not have to be double-poled. Some advise a single-pole disconnect which would open only the ungrounded conductor, so the array wiring can remain grounded at all times.)

In selecting DC protectors for solar array (or other charging source) leads, pay attention to the turn-on voltage of the device you are considering. Many 12 Volt suppressors start protecting at 17 or 18 Volts, which is less than the open circuit voltage of many solar modules. Such a protector will go to work every sunny time the array to battery connection is switched off, whether by an automatic regulator or manually operated switch. This could shorten the life of the protector and is also an NEC code violation. The surge arrestor should not activate when it senses an open circuited solar array or other charging source. This means that a 12 Volt system may wind up with a protector that is labeled for a higher system voltage.

AC protectors can be of either shunting or series design. Telephone lines, coaxial cables, and other things like wiring to a submersible pump can also carry induced surges into your structure. These are sometimes less of a threat because the incoming wires are smaller and therefore have more impedance. Coax cables are shielded so that their central conductors are less sensitive to nearby electromagnetic fields. Telephone company wires sometimes have moderate surge arrestors installed already. Even so, total hardening against lightning entails protection of these leads, as well. Special protection devices are available for all of these areas.

Regardless of the quality of surge suppressors you use, the level of protection against lightning will be no better than the grounding system they work with. Remember that lightning is trying to reach the earth. Your job is to give it a quick and easy way to do that without it going through your inverter, charge controller, etc.

Surge professionals recommend less than 5 ohms resistance between your ground rods and the earth. It's not unusual for a serious installer to exceed the requirements of the NEC.

Left: Professional spike arrestor for 120 vac; rated for NEMP.
Photo courtesy of PolyPhaser Corp.



Lightning Safety

Grounding is a complex subject beyond the scope of this article. See your Home Power index in HP#53 under "National Electric Code, Grounding." PolyPhaser has a book and video on the subject. These materials are aimed at engineering professionals and they place a particular emphasis on the needs of the two-way communications industry. Nevertheless, they can be a useful resource for those who want to know what the pros know.

Here's hoping the only surges on your power lines are the kind that keep your batteries charged!

Access

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